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REDUCING CANOLA SEED DAMAGE FROM METERING AND AIR DISTRIBUTION SYSTEMS

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Final Report

Reducing Canola Seed Damage from Metering and Air Distribution Systems

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1. Summary

Tests were conducted using air cart/metering and distribution systems from Conserva-Pak, Bourgault, and New Holland to quantify canola seed damage from the metering/air distribution system.

Test variables included two canola varieties (Hybrid and non-hybrid), two ground speeds at 5 and 6 mph (8 and 9.7 km/h), and four air speeds. Seed samples, for laboratory analysis, were taken before testing, after metering, and at the opener outlets.

Overall seed damage (physical and germination) due to metering and distribution was less than 10% with no measurable effect from ground or air speed. The open pollinated variety was more susceptible to damage compared to the hybrid variety.

2. Background and Objectives

In field surveys, the Canola Council of Canada (CCC) has discovered as much as a 30% reduction in seed canola germination from the air seeder tank to the outlet. As seed costs have increased dramatically over the last years and are likely to further increase with increased market acceptance of hybrid varieties, it is important to find ways to reduce these costs. This report will quantify seed damage through metering and pneumatic delivery of canola and determine methods of reducing seed damage through the adjustments of metering and air delivery systems.

3. Project Description

3.1 Air Cart/Air Delivery System

Bourgault, New Holland (Flexi-Coil), and Conserva-Pak provided air cart/air delivery systems for the project. Equipment provided by each manufacturer is in production or near production. Details of each manufacturer's system are described in **Section 3.3.1**. New Holland supplied a 40 ft (12 m) air drill, while the other two systems used standard air carts with test stands for the distribution system.

3.2 Seed Sampling Methodology and Laboratory Tests

Two varieties of seed (InVigor 5070 certified seed (hybrid) and Advanta HyLite 292 CL certified seed (open pollinated)) were used in this test. All of the bags from each variety had the same crop certificate number and lot number. Check samples were collected as the seed was transferred prior to entering the air cart. Metering system samples were collected using the standard calibration method from each manufacturer at a simulated ground speed of 5 mph (8.0 km/h) and 6 mph (9.7 km/h) with both seed varieties. Air cart/air distribution samples were collected in cloth bags or plastic pails (with cloth on the bottom of the pails to absorb impact) at the end of each air distribution hose. Samples from the hoses were combined (following weighing) and divided into subsamples using a Seedburo seed divider. The runs containing phosphate where sent through a Kliper fanning mill to separate 93% of the phosphate from the seed sample and then were divided with the Seedburo seed divider. All samples were double bagged in paper bags and sent to 2020 Seed Lab in Nisku, Alberta, for testing. Physical seed damage is the percentage of seed cracked (split seed coat), broken (1/2 the seed or less), and dehulled (seed coat completely removed). The germination test took 5 to 7 days and also recorded abnormal and dead seeds. A pre-chilled vigor test was also performed to determine seed performance in sub-optimal growing conditions.

The definition of vigor is "The sum total of those properties of the seed which determine the level of activity and performance of the seed or seed lot during germination and seedling emergence. Seeds which perform well are tested high vigor seeds." The aspect of seed emergence associated with the seed vigor includes: the rate and uniformity of seed germination and seedling growth, field performance that includes rate and uniformity of seedling emergence, and performance after storage and transportation. Performing a pre-chilled or cold germination vigor test determines the seedlings ability to withstand low temperature stress, which is associated with early spring seeding.

3.3 Test Methodology Common to All Manufacturers

3.3.1 Air Cart/Air Delivery Systems

Each machine was set up for static testing in PAMI's Crops Processing Centre at Humboldt, Saskatchewan. All machines were configured to factory specifications with representatives from each company present during final set-up and initial testing. Manufacturer's seed openers were used to test overall damage to the seeds before the seeds are planted in the ground. Each seeder was loaded with approximately 100 lb (50 kg) of treated canola very carefully and gently to ensure no seed damage while loading. A sample of the seed was collected prior to loading the tank. This sample was the check sample and was used to provide baseline information on physical seed damage and germination percentages. Each time a new batch of seed was loaded into the tank a new check sample was taken for comparison with the tests through the air tank/metering system.

All air cart/air delivery systems were calibrated using InVigor 5070 certified seed and Advanta HyLite 292 CL certified seed at a rate of 5 lb/ac (5.6 kg/ha) using factory instructions at a simulated ground speed of 5 mph (8.0 km/h) and 6 mph (9.7 km/h).

Metering system damage was measured separately from overall system damage to identify the source of the damage. Metering damage tests were conducted at a simulated ground speed of 5 mph (8.0 km/h) and 6 mph (9.7 km/h). Each machine was set up to catch metered samples using the factory methodology and the metering system was run for approximately 1 ac (0.4 ha).

Minimum fan speed (base minus 15%) was determined by dropping the recommended by 15% and then determining if the lines would plug at 5 mph (8.0 km/h) and 6 mph (9.7 km/h) simulated ground speed due to too low airflow. If plugging occurred, the minimum air speed was increased until plugging ceased. With the Bourgault system, the base minus 15% plugged the outside hoses so the minimum was raised to base minus 7.5%. The other two machines operated at minus 15% airflow without plugging. All fan speeds were set under no load using factory recommendations. The machines airflow was also measured and recorded under load.

To determine the effect of airflow and ground speed on the germination and vigor of InVigor 5070 and Advanta HyLite 292 CL, 24 tests were run with each machine. Simulated ground speeds of 5 mph (8.0 km/h) and 6 mph (9.7 km/h) were run at manufacturers recommended airflow (base), base plus 15%, base plus 50%, base minus 15%, and base plus or minus phosphate.

Representative samples were taken from each of the 24 runs by dividing the combined seed down to an acceptable size using a Seedburo seed divider. A Kliper Fanning Mill cleaned the samples containing phosphate. The machine was set up with minimal fan, a canola seed screen was used to separate the canola from the phosphate, and the bottom screen was covered with duct tape to create a solid screen. The solid screen prevented the loss of small and cracked seeds.

Conserva-Pak: The Conserva-Pak system included a tow between Conserva-Pak 4400 air cart with 112 hoses running behind the air cart. The air cart consisted of two smaller tanks and two larger tanks. There were 56 hoses for the left metering bank and 56 hoses for the right metering bank (**Figure 1**). The 56 hoses on both the left and right bank is divided into two groups of 28 hoses. The top 28 hoses ran the small and large tank on the rear while the bottom 28 hoses ran the large and small tank in the front of the air cart. The 28 hoses that were used had production length hoses connected to them to simulate half of a 56 ft seeder. The 28 hoses that were used had Conserva-Pak openers on them and were placed in plastic and cloth bags to catch the seed (**Figure 2**).

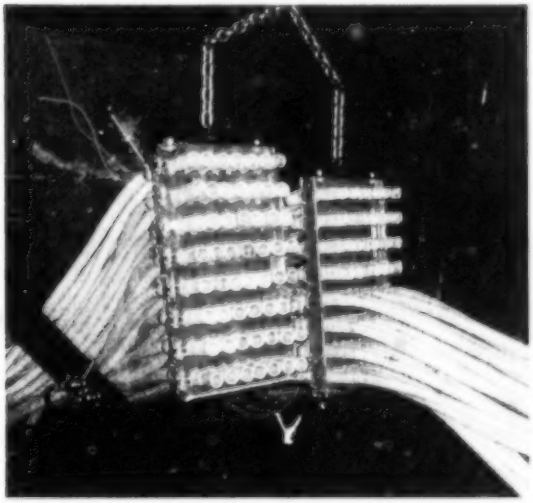

Figure 1. Hose Bank at the Rear of the Air Tank.

A hydraulic motor with a flow control valve was mounted on the end of the metering drive wheel shaft and was used to simulate target ground speeds. A fine roller was used to meter the canola and a medium roller was used to meter the phosphate (**Figure 3**). Half of the small front tank was used for the seed due to the small seeding volumes associated with canola (**Figure 4**).

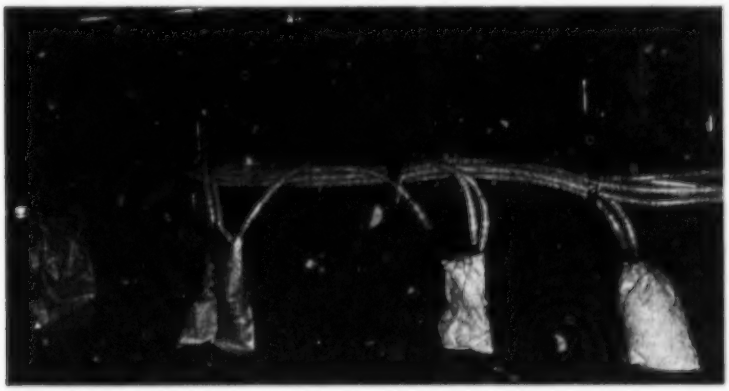

Figure 2. Plastic and Cloth Bags Used to Catch Seeds.

Figure 3. Fine and Medium Rollers.

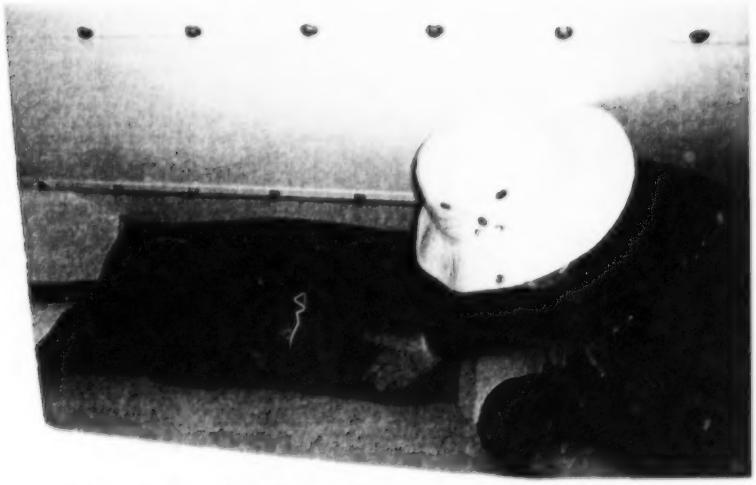

Figure 4. Small Tank Used for Seed.

Bourgault: The Bourgault system included a tow behind Bourgault 6550 air cart with an air kit mounted on test stands (**Figure 5**). Seed and fertilizer were metered from the air tank with an auger type system into one large primary distribution hose. The canola meter used a double fluted steel auger (**Figure 6**) while the fertilizer meter had a single

flight polyurethane auger. The primary hose ran past the rear of the air cart where it entered the bottom of the primary manifold with six outlets. Each of these hoses ran into a secondary manifold with 11 delivery hoses (**Figure 5**). The delivery hoses were inserted into plastic pails with cloth on the bottom to absorb the impact at the bottom of the pail. The standard Bourgault boots were very streamlined and probably would have caused little or no seed damage. They were left off of the hoses to help speed up the testing process. However, to verify this, additional tests were run after completion of the tests using the standard square Bourgault boot and Bourgault Tillage Tools 200-KNf-7510 narrow opener. When seeding with a Bourgault seeder, phosphate is always run with the seed. All of Bourgault's runs had phosphate included except for one run which was base minus P.

Ground speed was simulated using a hydraulic motor drive and was measured by the Bourgault monitor system. Seed was placed in the smallest tank due to the small seeding volumes associated with canola.

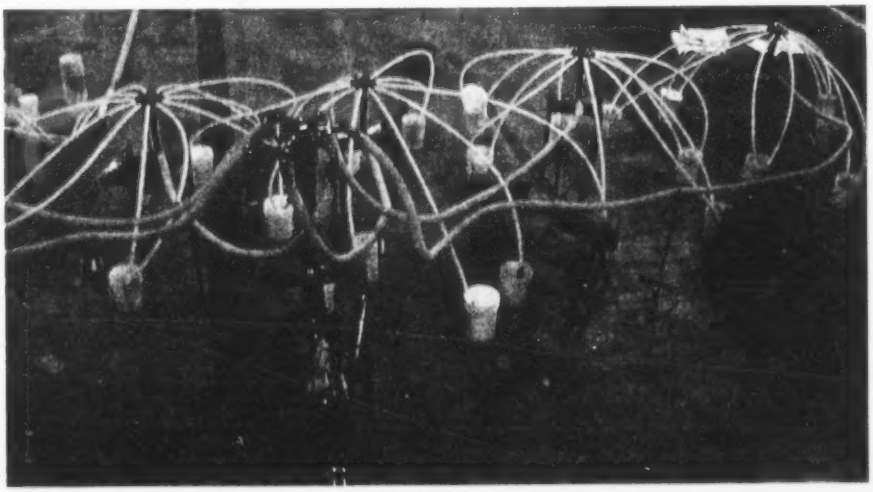

Figure 5. Air Kit Mounted on Test Stands.

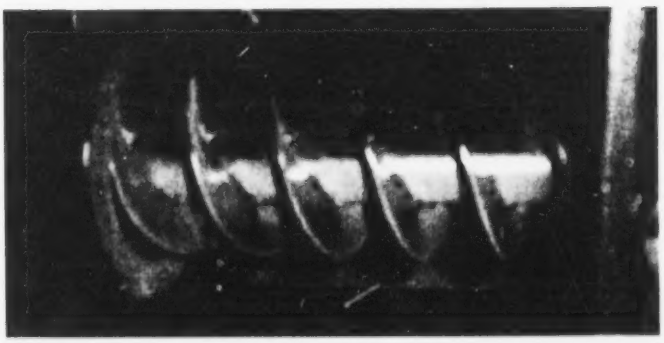

Figure 6. Double Fluted Steel Auger.

New Holland: The New Holland system included a New Holland SC230 air cart with a 40 ft SD440 Air Drill. Seed is metered from one long external fluted extra fine metering roller into six individual distribution hoses (**Figure 7**), while a long external fluted coarse metering roller metered the phosphate into six individual distribution hoses. Each hose ran to a manifold with nine delivery hoses (**Figure 8**). The delivery hoses were inserted into the Flexi-Coil Stealth double-shoot side band openers and then placed into a pail with cloth on the bottom to absorb impact (**Figure 9**). The metering system on the New Holland air cart was operated with the factory New Holland electronically controlled drive system.

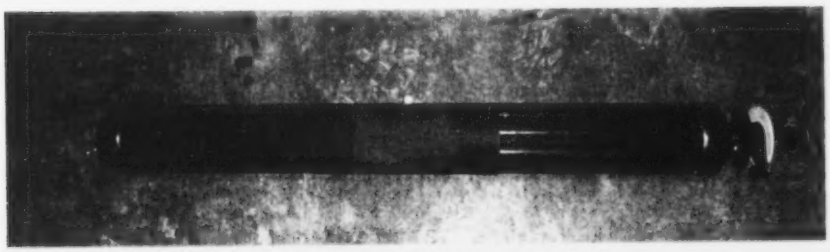

Figure 7. Long External Flutes Extra Fine Metering Roller.

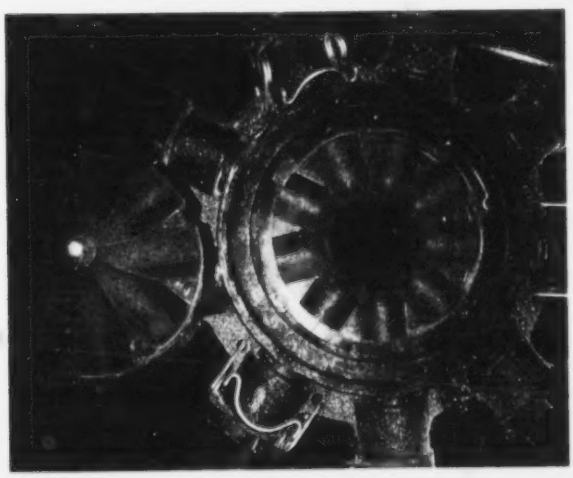

Figure 8. Easy Flow Header Manifold.

Figure 9. Pail Set-up.

Ground speed sensing on the New Holland was simulated with an electronic device that simulated the pulse/second reading of the speed sensor located on the wheel. The front tank is the smaller of the two tanks so it was used to hold the canola while the rear tank held the phosphate. The double shoot air cart was equipped with a plenum flow divider that allowed the operator to set the airflow to each product stream. The runs without phosphate were in double shoot configuration without applying fertilizer, while the run that used phosphate was set up for single shoot. The damper on the phosphate tank was adjusted to increase the air stream velocity to compensate for the volume of phosphate. The canola was mixed in with the phosphate air stream.

The base air velocity was determined from the air speed chart in the owner's manual and verified by using the New Holland vertical hose technique. The vertical hose technique was also used to verify that the base airflow minus 15% was sufficient airflow for the machine to prevent plugging the lines.

4. Results and Conclusion

The vigor and germination graphs include the physical seed damage graph because the seeds that were reported physically damaged were seeded.

Data received from the lab had a wide variation in results and no relationship was evident between germination/vigor effects and fan or ground speed.

The overall physical seed damage resulting from only the metering systems were low with Conserva-Pak having zero percent with both varieties, Bourgault had 0.5 percent with InVigor 5070 and 8.5 percent with Clearfield 292, and New Holland having zero percent with both varieties.

4.1 Conserva-Pak Air Cart/Air Delivery System Results and Discussion

Metering and airflow damage with the two varieties of canola in the Conserva-Pak system using Conserva-Pak openers was below 6% at both simulated ground speeds.

The baseline airflow for the Conserva-Pak system with 5 lb/ac (5.6 kg/ha) seed rate of Canola was 8 in (200 mm) of water manifold pressure at both ground speeds. All combinations of ground speeds and pressures are listed in **Table 1**.

Table 1. Conserva-Pak Fan and Ground Speeds.

Machine	Fan speed	Targeted Manifold Pressure	Actual Manifold Pressure	Ground speed (mph)
	Metering			
C	Base	8 inches of water	8 inches of water	5
O	Base-15%	6.8 inches of water	6.8 inches of water	5
N	Base+15%	9.2 inches of water	9.2 inches of water	5
S	Base+50%	12 inches of water	12 inches of water	5
E	Base+P	10 inches of water	10 inches of water	5
R				
V	Metering			
A	Base	8 inches of water	8 inches of water	6
-	Base-15%	6.8 inches of water	6.8 inches of water	6
P	Base+15%	9.2 inches of water	9.2 inches of water	6
A	Base+50%	12 inches of water	12 inches of water	6
K	Base+P	10 inches of water	10 inches of water	6

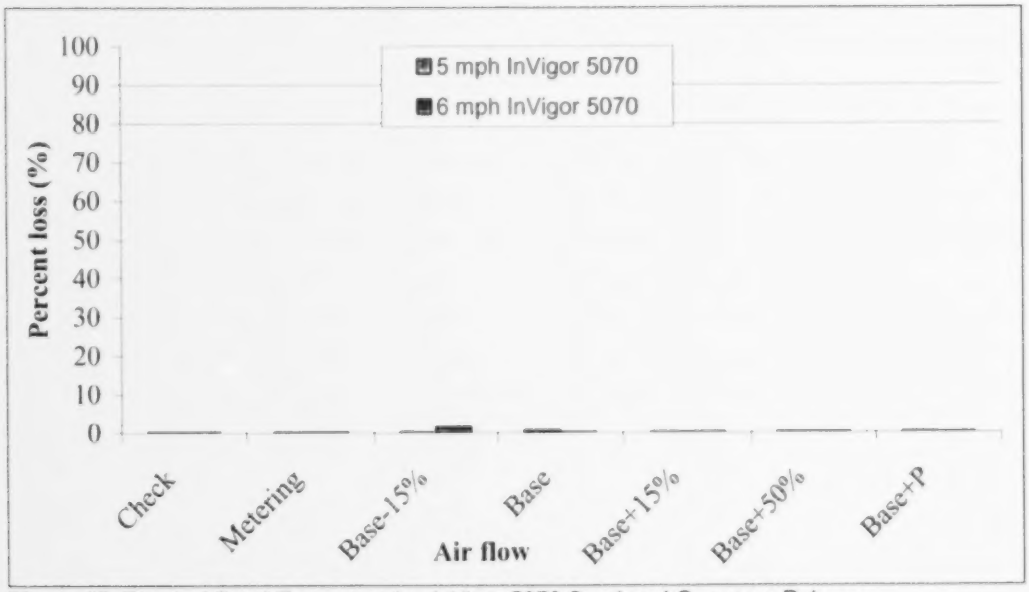

Figure 10. Physical Seed Damage using InVigor 5070 Seed and Conserva-Pak.

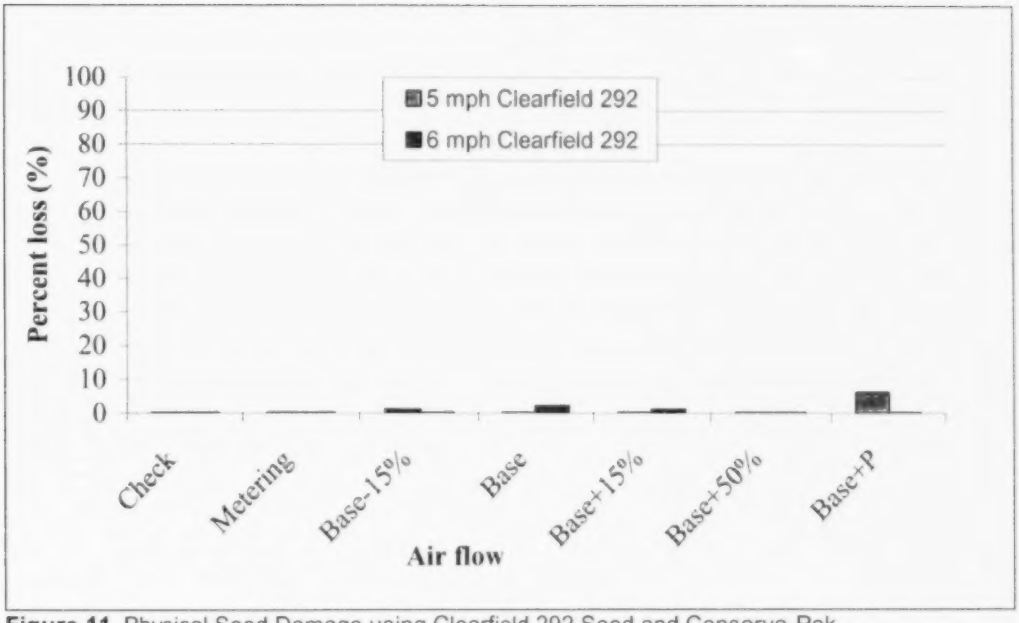

Figure 11. Physical Seed Damage using Clearfield 292 Seed and Conserva-Pak.

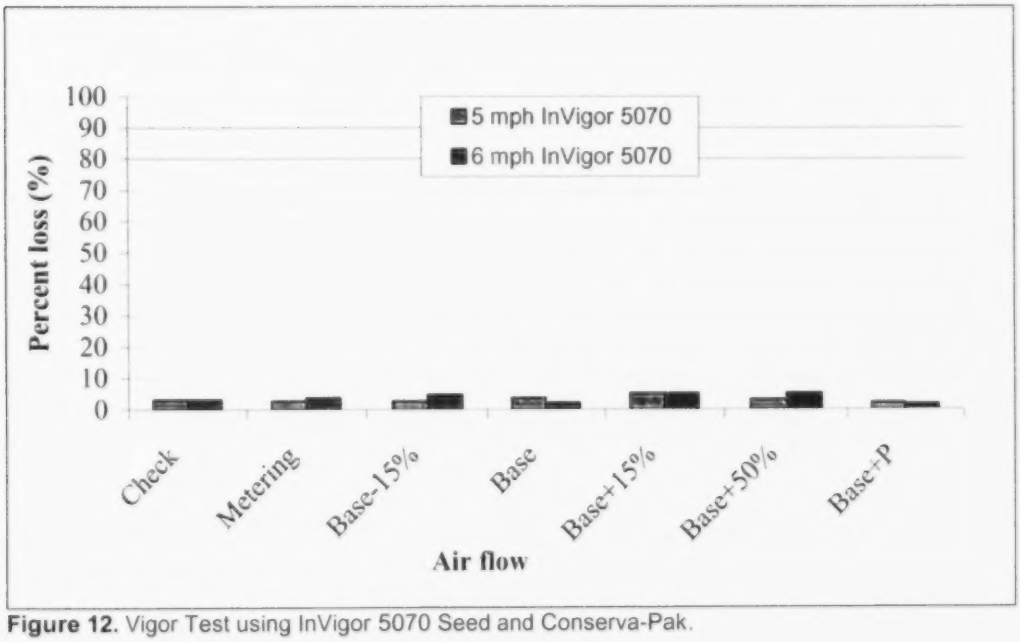

Figure 12. Vigor Test using InVigor 5070 Seed and Conserva-Pak.

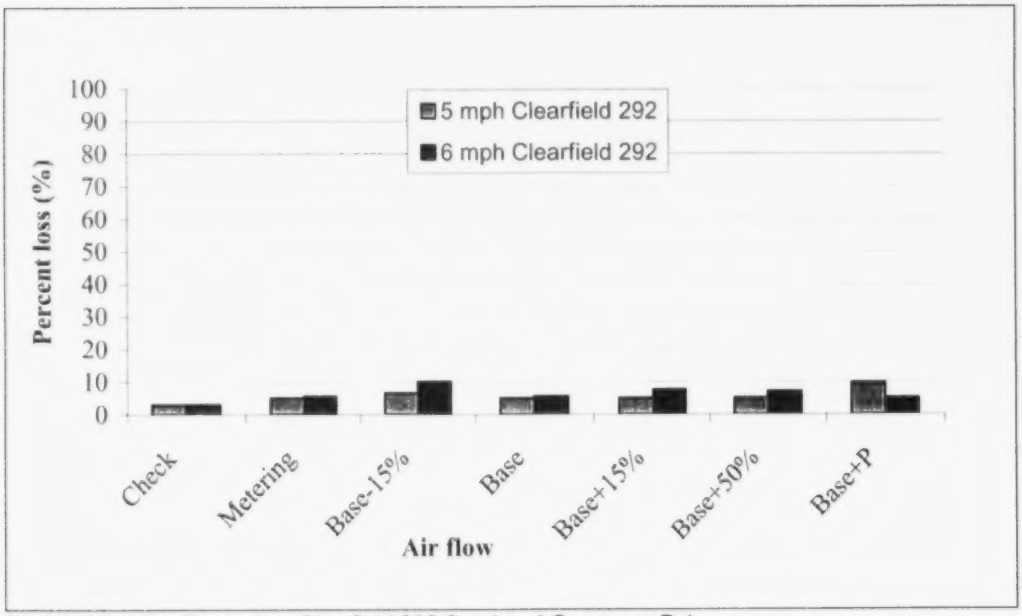

Figure 13. Vigor Test using Clearfield 292 Seed and Conserva-Pak.

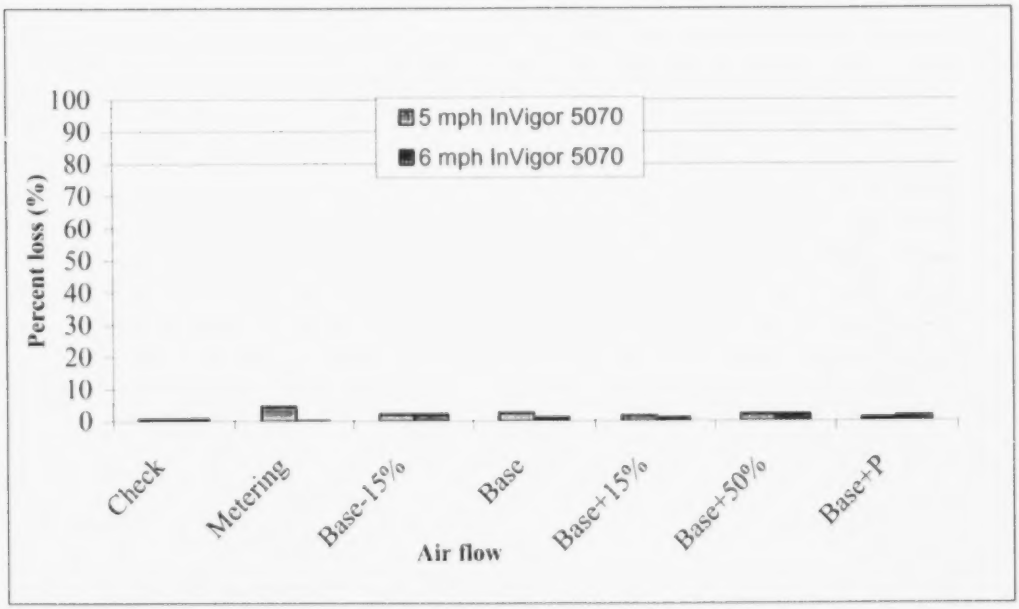

Figure 14. Germination Test using InVigor 5070 Seed and Conserva-Pak.

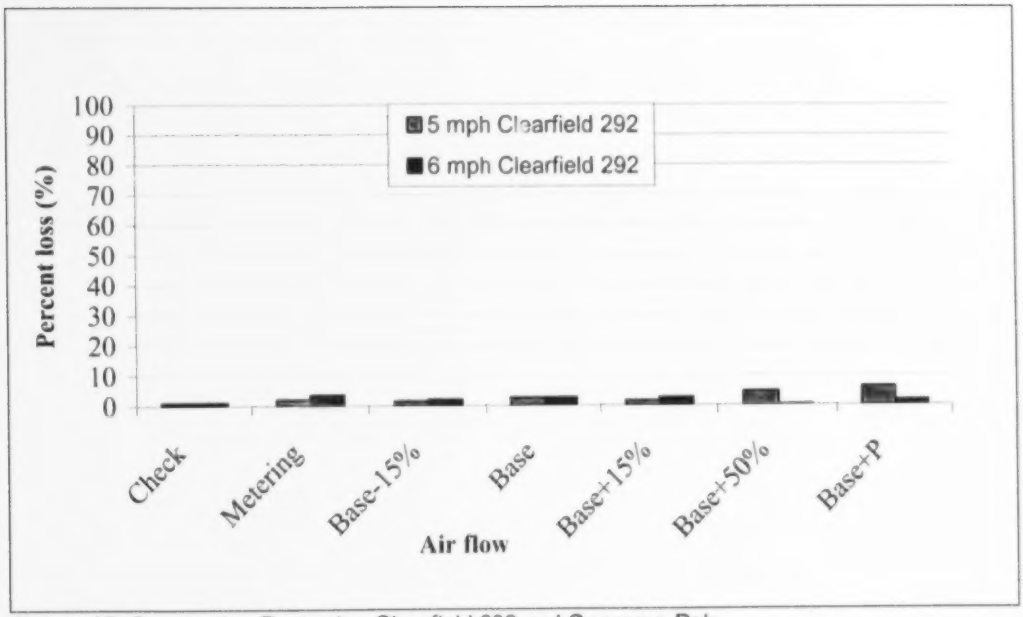

Figure 15. Germination Test using Clearfield 292 and Conserva-Pak.

With the Conserva-Pak system, seed damage, vigor and germination were not affected by airflow or ground speed. The only evident trend is the effect of the different seed varieties. InVigor 5070, had 5% or less damage throughout the test while the other variety, Clearfield 292, had 10% or less damage. The Conserva-Pak machine performed well overall.

4.2 Bourgault Air Cart/Air Delivery System Results and Discussion

Metering system damage with both varieties of canola in the Bourgault system was below 10 % at both simulated ground speeds.

The Clearfield 292 graphs have "no data" for metering and base airflow as the two samples were lost and not available for analysis. The baseline airflow for the Bourgault system with 5 lb/ac (5.6 kg/ha) seed rate of canola was 2550 and 2680 fan rpm at 5 and 6 mph (8 and 9.7 km/h) ground speeds respectively. All combinations of ground speeds and fan speeds are listed in **Table 2**.

Table 2. Bourgault Fan and Ground Speeds.

Machine	Fan speed	Targeted fan (rpm)	Actual fan (rpm)	Ground speed (mph)
BOURGAULT	Metering			
	Base	2550	2560	5
	Base-7.5%	2380	2380	5
	Base+15%	2930	2930	5
	Base+50%	3825	3850	5
	Base-P	2000	2050	5
	Metering			
	Base	2680	2690	6
	Base-15%	2480	2490	6
	Base+15%	3080	3080	6
	Base+50%	4020	4030	6
	Base-P	2100	2120	6

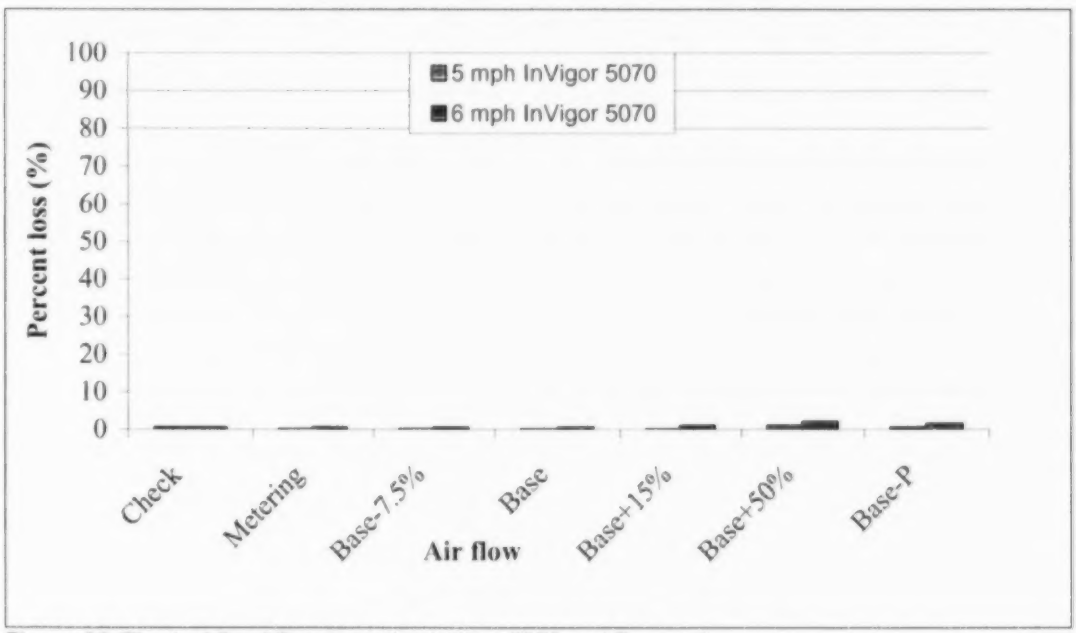

Figure 16. Physical Seed Damage using InVigor 5070 and Bourgault.

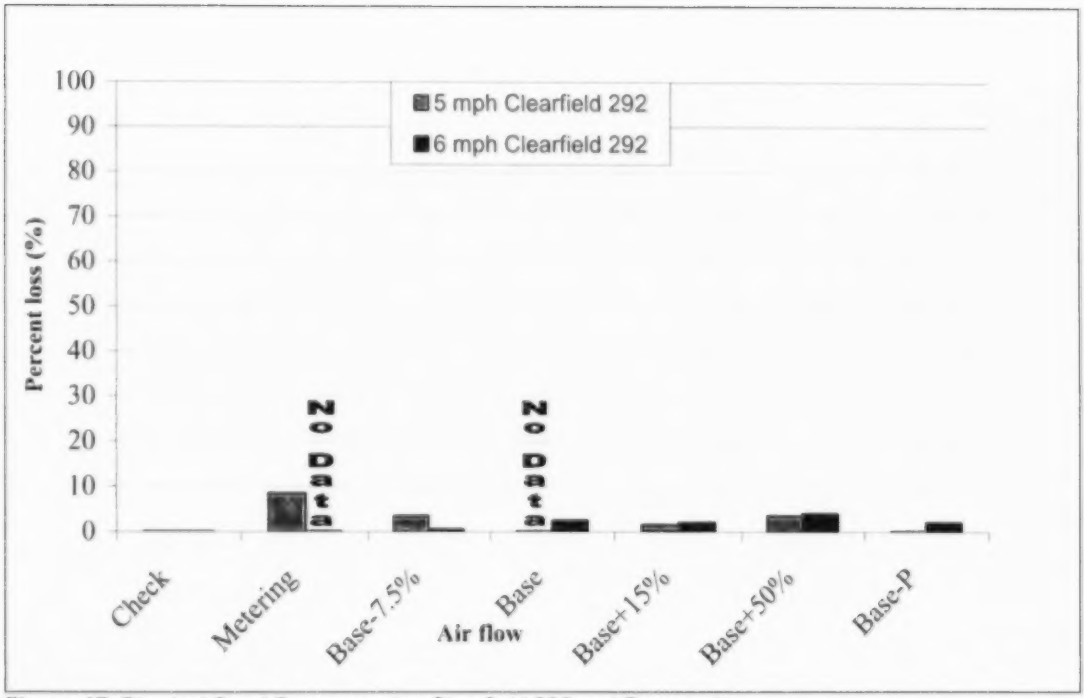

Figure 17. Physical Seed Damage using Clearfield 292 and Bourgault.

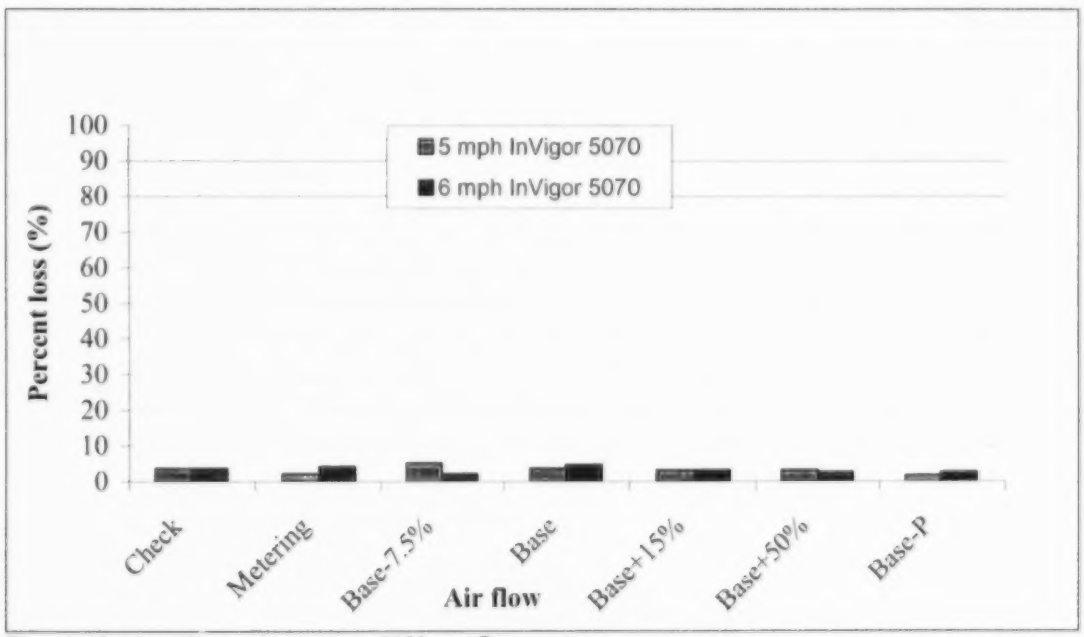

Figure 18. Vigor Test using InVigor 5070 and Bourgault.

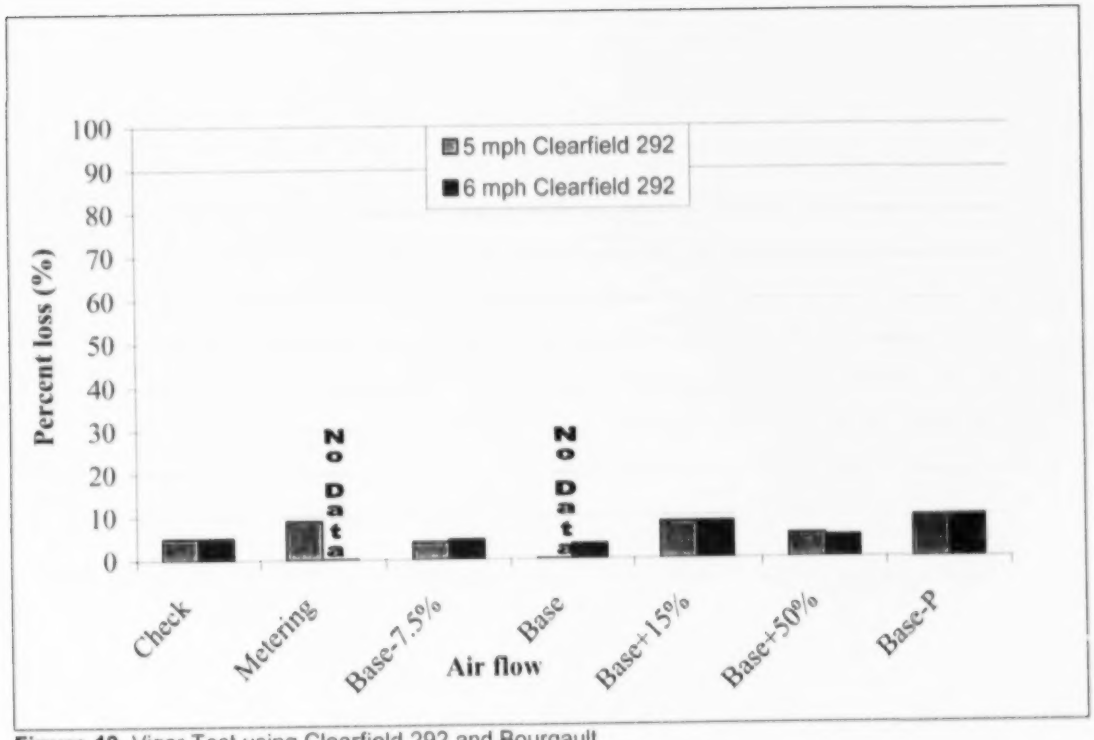

Figure 19. Vigor Test using Clearfield 292 and Bourgault.

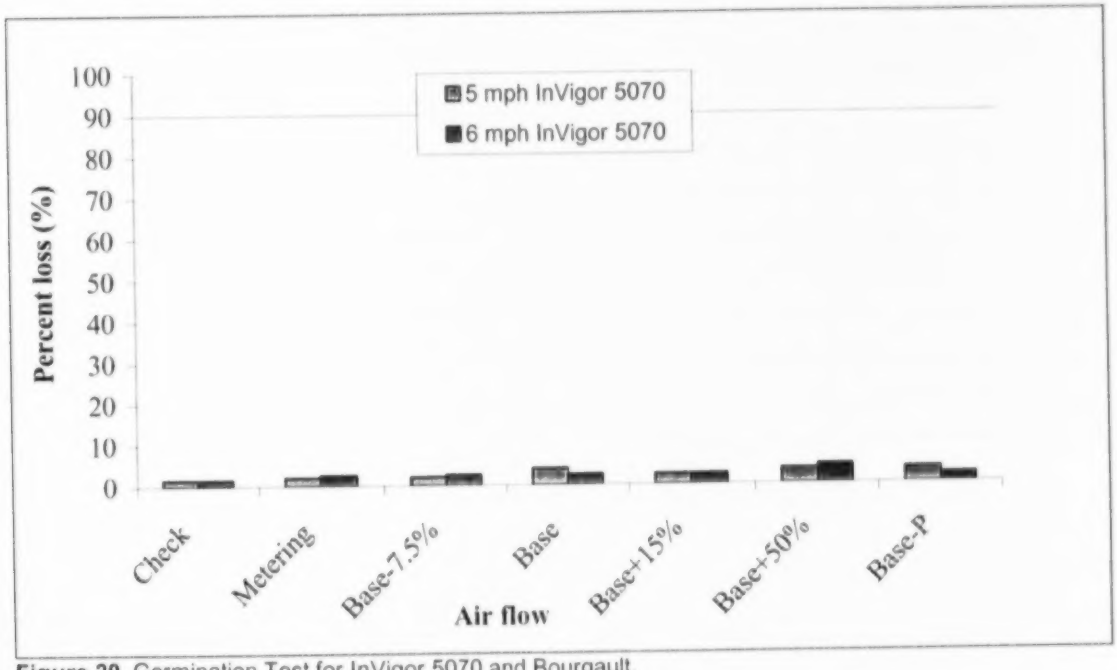

Figure 20. Germination Test for InVigor 5070 and Bourgault.

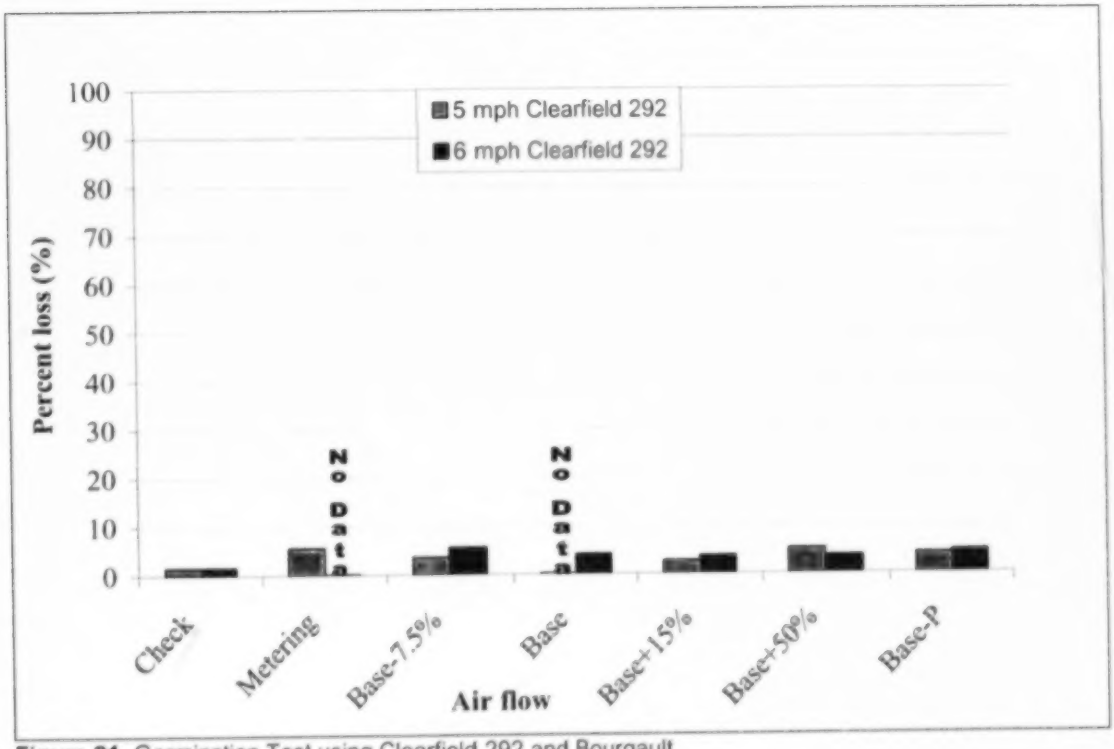

Figure 21. Germination Test using Clearfield 292 and Bourgault.

With the Bourgault system, seed damage, vigor and germination were not affected by fan or ground speed. The only evident trend is the effect of the different seed varieties. InVigor 5070, had 5% or less damage throughout the test while the other variety, Clearfield 292, had 9.5% or less damage. As the Conserva-Pak and New Holland systems were tested using seed openers and the Bourgault system was initially tested without openers, additional testing was completed using Bourgault square boots and Bourgault Tillage Tool openers. Overall results of the extra tests indicated essentially no difference in seed damage, germination or vigor due to the addition of the boots and openers. The Bourgault machine performed well overall.

4.3 New Holland Air Cart/Air Delivery System Results and Discussion

Metering system damage with the two varieties of canola in the New Holland system was below 8% at both simulated ground speeds.

Baseline airflow for the New Holland system with 5 lb/ac (5.6 kg/ha) seed rate of canola was 2700 and 2800 air velocity at 5 and 6 mph (8 and 9.7 km/h) ground speeds respectively. All combinations of ground speeds and pressures are listed in **Table 3**.

Table 3. New Holland Fan and Ground Speeds.

Machine	Fan speed	Targeted air velocity	Actual air velocity	Ground speed (mph)
	Metering			
N	Base	2700	2600	5
E	Base-15%	2300	2300	5
W	Base+15%	3100	3100	5
	Base+50%	4050	4000	5
H	Base+P	4700	4600	5
O				
L	Metering			
L	Base	2800	2800	6
A	Base-15%	2380	2400	6
N	Base+15%	3200	3200	6
D	Base+50%	4200	4200	6
	Base+P	4900	4500	6

Note: Targeted air velocity for the phosphate runs are measured on the phosphate side.

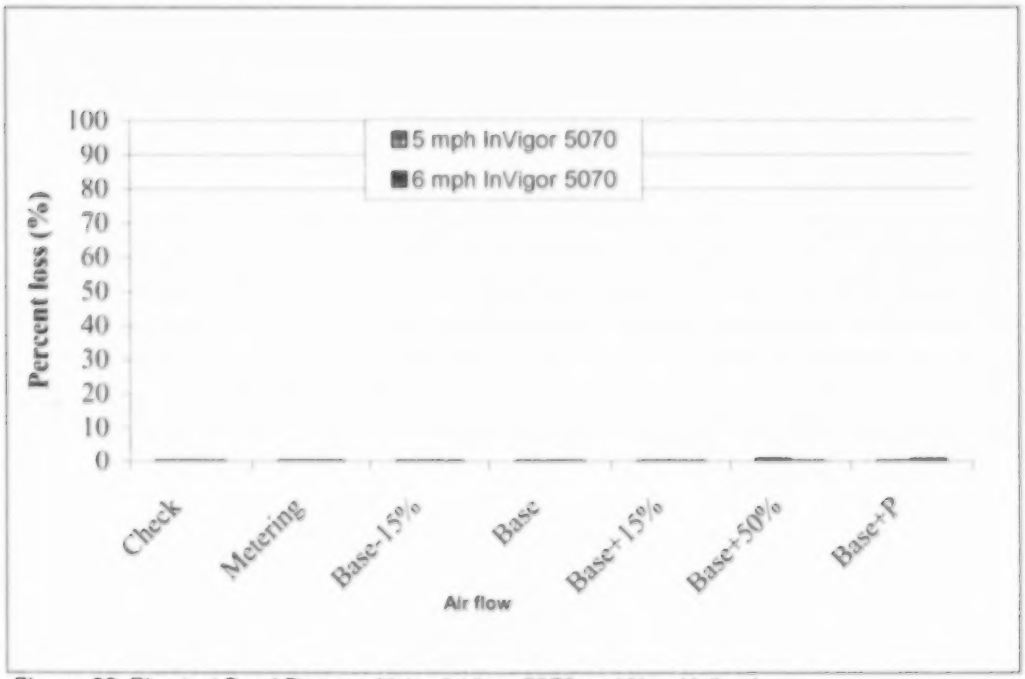

Figure 22. Physical Seed Damage Using InVigor 5070 and New Holland.

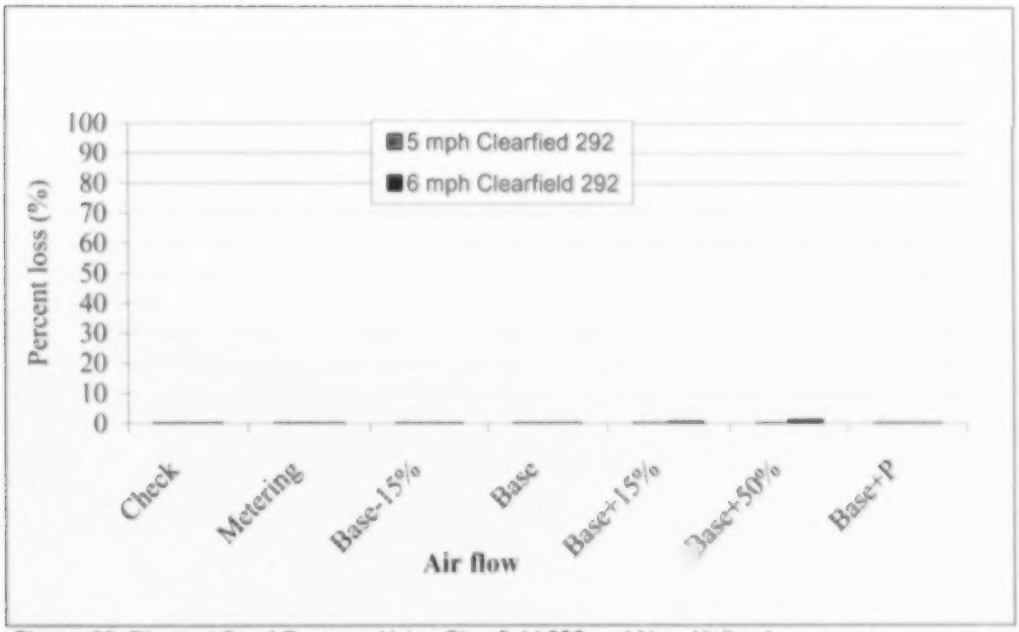

Figure 23. Physical Seed Damage Using Clearfield 292 and New Holland.

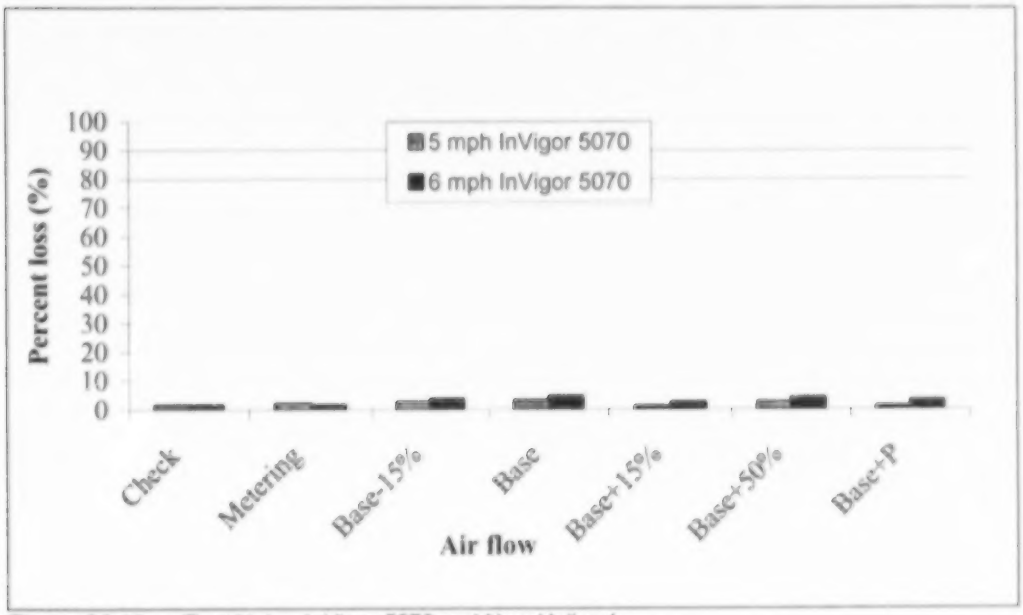

Figure 24. Vigor Test Using InVigor 5070 and New Holland.

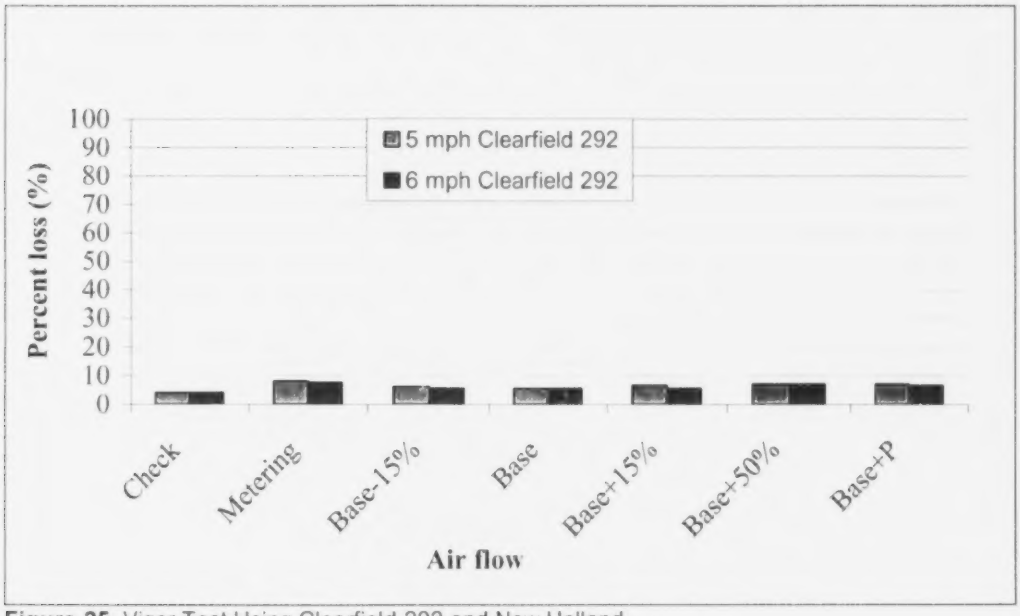

Figure 25. Vigor Test Using Clearfield 292 and New Holland.

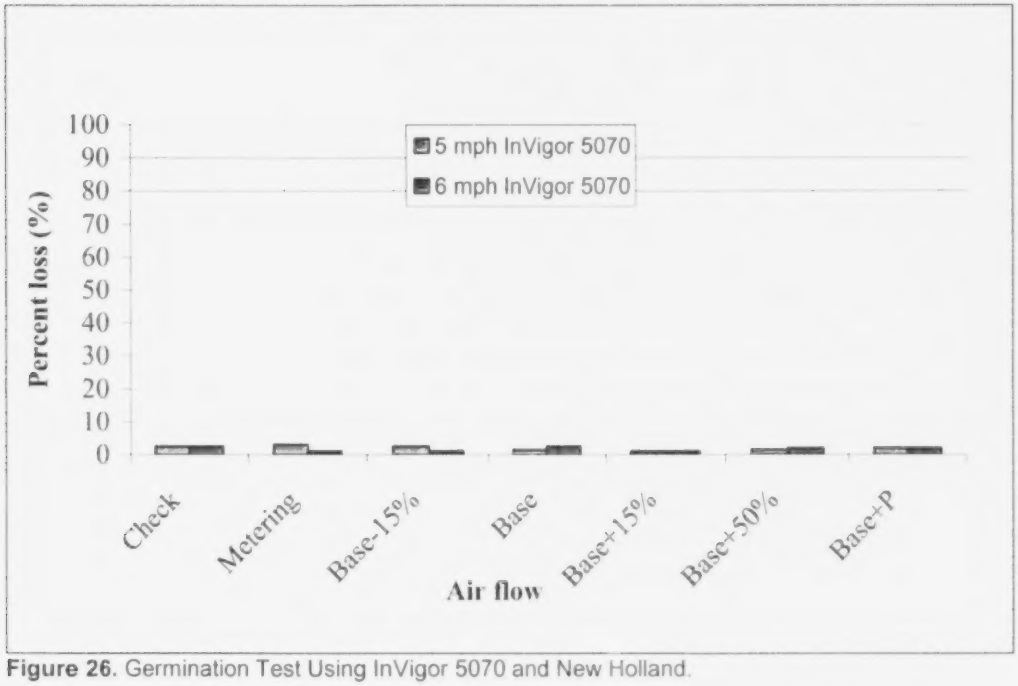

Figure 26. Germination Test Using InVigor 5070 and New Holland.

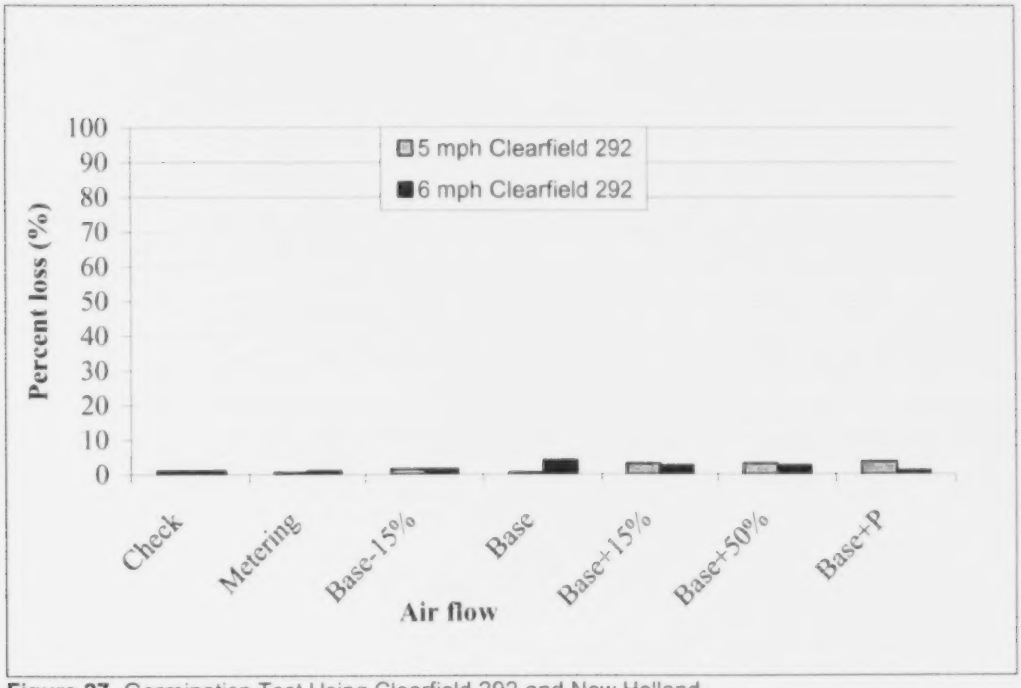

Figure 27. Germination Test Using Clearfield 292 and New Holland.

With the New Holland system, seed damage, vigor and germination were not affected by airflow or ground speed. The only evident trend is the effect of the different seed varieties. InVigor 5070, had 4.5% or less damage throughout the test while the other variety, Clearfield 292, had 8.0% or less damage. The New Holland machine performed well overall.

Canola is a very flexible crop in that variations in seeding rate or plant population over relatively wide ranges normally have little effect on the final yield. A seed distribution or plant population range of 60 to 180 plants per square meter will result in the same yield.

5. Conclusion

In summary, metering and air distribution seed damage was very low with all 3 machines resulting with less than 10% reduction in germination and vigor. The pollinated variety was more susceptible to damage compared to the open hybrid variety.

The seed damage caused by the air distribution system was also low. Using the more sensitive vigor test, the Conserva-Pak had 5.0% loss with InVigor 5070 and 10.0% loss with Clearfield 292. New Holland had 4.5% loss with InVigor 5070 and 8.0% loss with Clearfield 292. Bourgault had 5.0% loss with InVigor 5070 and 9.5% loss with Clearfield 292.

Results from these tests conflicted with the field surveys conducted by the Canola Council of Canada. It is not understood why the seed damage from field surveys is much larger than from the laboratory studies.